



National Aeronautics and Space Administration

# From Rockets to Ruins

*The PEPCON Ammonium Perchlorate Plant Explosion*

## Senior Management ViTS Meeting

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# BACKGROUND

**May 4, 1988, Clark County, NV:** May 4, 1988, Clark County, NV: What began as a normal repair procedure at the Pacific Engineering Production Company of Nevada (PEPCON), a chemical plant specializing in a major component in solid propellant, ended in the worst way imaginable. While many workers left for lunch, sparks from a repair crew welding torch set ablaze fiberglass infrastructure. The flames, which grew out of control, soon engulfed PEPCON's massive stock of oxidizer, creating the largest domestic, non-nuclear explosion in recorded history. The explosion affected structures in a 10-mile radius, accrued damages estimated at \$100 million, injured approximately 372 people, and ended the lives of 2 plant employees.

## Ammonium Perchlorate (AP)

- Ammonium perchlorate (AP), is mixed with finely ground aluminum and other combustible materials to create solid propellants.
- Although classified as less hazardous than mixed fuel, AP greatly accelerates the explosive properties of combustible material.

## The PEPCON Facility

- At the time of the explosion, PEPCON was one of two major producers of AP worldwide.
- The other producer, Kerr-McGee, was less than 2 miles away.
- PEPCON operated in Clark County, NV, 10 miles southeast of Las Vegas, NV, near Henderson, a suburb with a 1988 population of approximately 50,000.
- The 1988 NASA launch stand down following the Challenger disaster froze PEPCON AP shipping, yet had no effect on PEPCON AP contract orders with Space Shuttle Solid Rocket Booster (SRB) manufacturer Morton Thiokol.
- During the next 15 months, PEPCON accumulated a stockpile of over 4,000 tons of the oxidizer.



# WHAT HAPPENED

## Ignition

- 11:30 a.m. Pacific Daylight Time (PDT), workers were making repairs with a welding torch when sparks ignited some fiberglass building material.
- Fire spread to 55-gallon AP storage drums stacked next to the structure, accelerated by general profusion of AP residue in facility.
- 11:40~11:50 a.m., the first explosion occurred.
  - No alarm or announcement system was installed at the facility
  - No sprinkler system existed in the processing structures
  - According to policy, personnel were to evacuate the premises if they observed a fire; however, there was no formal evacuation plan
  - PEPCON had 77 employees; 75 escaped, running or driving away through the desert; 2 were killed
  - One confined to a wheelchair, the other—who was also handicapped—stayed behind to alert emergency dispatchers of the situation

## Major Explosions

- 11:53 a.m., multiple 55-gallon drums exploded into a giant fireball—first of two major blasts—approx. 100 feet in diameter, registering 3.0 on Richter scale at observatories in California and Colorado .
- 11:57 a.m., the fire reached large, aluminum 5,000-pound AP shipping containers, resulting in the incident's largest explosion, 3.5 on the Richter scale at the CA and CO observatories.
  - Later investigators surveyed the damage, estimating the blast damage as similar to a 1-kiloton airblast nuclear explosion
  - Affected area spanned a 10-mile radius from the facility
- Several area fire departments responded with mutual aid, but no attempt was made to approach or fight the fires, which were beyond the departments' suppression capability.

# PROXIMATE CAUSE

Sparks from a welding torch during repairs ignited fiberglass material. The fire grew at an accelerated rate because a profusion of AP residue at the facility. A surplus of AP exploded in the fire.

## UNDERLYING ISSUES

### Stockpile

- Shuttle launches were postponed in wake of the Challenger disaster and the Rogers Commission; however, the SRB manufacturer did not alter or halt contracted AP production.
- AP production continued unchanged.

### PEPCON Storage Practices

- PEPCON containment options included
  - 5,000-pound capacity aluminum bins
  - 250-pound capacity polyethylene lined steel drums
  - 2,400-pound capacity fiber reinforced polypropylene bags
  - 550-pound capacity high-density polyethylene drums
- All storage containers were composed of or contained oxidizable material.
- Over 10,000 550-pound capacity drums were stored around the facility, often wherever extra space dictated as surplus accumulated.
  - The drums were chosen for convenience and corrosion control.
- Investigators suggested that the inclusion of the polyethylene drums had amplified the magnitude of the PEPCON blasts.

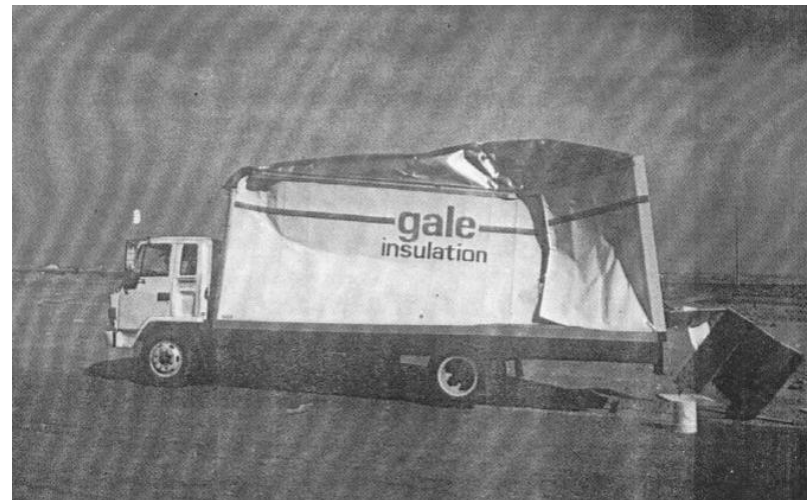




# UNDERLYING ISSUES

## Complacency

- AP residue was present throughout the facility from years of production.
- Housekeeping was only performed thoroughly when inspections were scheduled.
- PEPCON never installed an alarm or sprinkler system despite previous batch dryer building fires.



# AFTERMATH

- In their report, the U.S. Fire Administration, the Federal Emergency Management Agency (FEMA), and the National Fire Data Center along several other lessons learned focused on
  - public need for accurate and timely information during emergency conditions
  - consideration of human nature during evacuation planning
  - safely evacuating handicapped individuals from disaster areas
- The U.S. Fire Administration, FEMA, and the Department of Energy (DOE) also noted that several vital safety procedures and systems were lacking at PEPCON, in particular
  - better housekeeping
  - elimination of fuel sources and combustible building products
  - ventilation systems,
  - sprinkler and deluge systems, alarms, fire sensing systems
  - evacuation procedures
  - fire watch practices
- These fire watch inadequacies become deadly, especially without a robust hot work permit system in place.
- PEPCON never rebuilt the Henderson site, but changed its name to Western Electrochemical Co. and built a new AP plant in Cedar City, UT which is still in operation.
- Since 1988, one deadly explosion (involving one victim killed and three other wounded) has occurred involving a spark that caused a flash fire and explosions.
- Official investigators blamed the blasts on welders, cramped storage, poor housekeeping, and windy weather.

# RELEVANCE TO NASA

- Although NASA continues to reassess and replace aging containment systems and methods, the storage of hazardous material presents an everlasting requirement of caution.
- The dangers of potentially hazardous material (e.g., ammonium perchlorate, solid propellant, liquid propellant, hydrogen, hypergols) force us to realize things that have never happened before happen all the time.
- Planning for failure, like designing for success, sometimes depends upon key assumptions to scope and scale the effort to the resources available. This can lead to planning for the scenarios considered most likely, instead of worst credible.
- Coping with the worst credible outcome can easily exceed available resources; NASA should not only plan to prevent the (disastrous) outcome, but also how best to recover lost critical functionality by accessing other resources.
- Although the PEPCON disaster could have been even more catastrophic in terms of loss of life, the effect of disasters have resounding impact on the public in close proximity and also those far away.

